

I. THE PRESENT STATUS OF THE LEPROSY
PROBLEM IN HAWAII

II. THE REACTION OF LEPERS TO MORO'S
"PERCUTANEOUS" TEST

III. A NOTE UPON THE POSSIBILITY OF THE
MOSQUITO ACTING IN THE TRANSMIS-
SION OF LEPROSY

BY

WALTER R. BRINCKERHOFF, S. B., M. D.

DIRECTOR, LEPROSY INVESTIGATION STATION,
MOLOKAI, HAWAII

Investigations made in accordance with
the Act of Congress approved
March 3, 1905



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TREASURY DEPARTMENT

Public Health and Marine-Hospital Service of the United States

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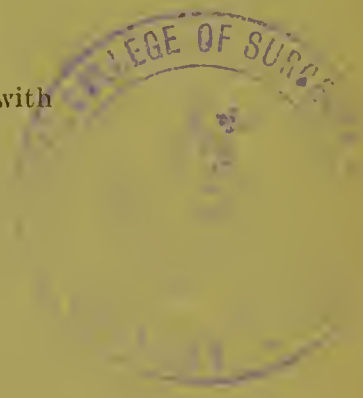
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INTRODUCTORY NOTE.

Leprosy has had an important influence on public health and social conditions in the Hawaiian Islands for many years, and notwithstanding the fact that isolation of the disease has been practiced for more than four decades, it continues to be a serious problem and a tax upon the resources of those islands.

The disease has also been shown to be widely disseminated throughout the United States. A commission of medical officers of the United States Public Health and Marine-Hospital Service, appointed in accordance with the act of Congress approved March 2, 1899, investigated the prevalence of the disease and rendered a report,^a which shows that there were at least 278 well-authenticated cases at that time existing in 21 separate States and Territories. The cause of the disease is now known and recognized as being a specific organism—the *Bacillus lepræ*, discovered by Hansen—but little is known of the method of its transmission or of the channels through which it effects an entrance into the human economy.

With the acquisition of Hawaii by the United States, leprosy became more than ever a national problem, and it was recognized that the disease should receive serious study with the view to eliciting further information as to the methods of its dissemination and with the hope that a cure would eventually be evolved.

Representations were therefore made to Congress urging the establishment of a leper investigation station on the island of Molokai, in order that advantage might be taken of the excellent opportunities afforded by the leper settlement for scientific study of the disease. As a result, Congress passed an act, which was approved March 3, 1905, providing for the investigation of leprosy in Hawaii. In accordance with the provisions of this act, a suitable tract of land was ceded by the Territory of Hawaii to the United States, and steps were taken to establish thereon a hospital station and laboratory of the Public Health and Marine-Hospital Service. The construction of the necessary buildings is nearing completion, and in the meantime Dr. Walter R. Brinckerhoff, who was appointed director of the station, has been engaged in scientific studies of the disease. While investigations of this character present problems of unusual difficulty, they are sure to advance our knowledge of the disease and to result in improved treatment and possible cure.

^a Senate Document 269, Fifty-seventh Congress.

THE PRESENT STATUS OF THE LEPROSY PROBLEM IN HAWAII.

By WALTER R. BRINCKERHOFF, S. B., M. D.,

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and Marine-Hospital Service, Honolulu, Hawaii.*

Leprosy became a public health problem in Hawaii in 1863, when the spread of the disease amongst the native race alarmed the community. Since the year 1865 the policy of segregation for the control of the disease has been pursued with varying degrees of thoroughness.

I wish to present for your consideration statistical and other data to show how the methods adopted to control the disease have met the problem, and further to suggest how in the future the situation might be more fully met.

OCCURRENCE AND GEOGRAPHICAL DISTRIBUTION.

The records of the board of health of Hawaii show that lepers were first sent to the leper settlement on the island of Molokai in 1866. During that year 142 cases were segregated. Since that time the number of cases committed to the settlement has varied within wide limits. The largest number were sent in 1887, when 558 cases were committed. The smallest number segregated in one year was 27, in 1870.

In all 5,853 cases have been sent to the leper settlement in the forty years from 1866 to 1905. This shows an annual average of over 146 cases. In 1900, the year of the first census taken under American rule, there were 37,635 Hawaiians in the Territory; of these 951 were lepers in segregation. In other words, 2.5 per cent of the natives, or 1 in 40, or 25 per thousand, were known lepers.

In this computation the inhabitants of the Territory of nationalities other than Hawaiians are not considered, as the disease in this Territory is almost exclusively a disease of the native race.^a

In 1876 the native population, estimated from the census of 1872 and 1878, was 50,188, with 680 natives known lepers. This shows 1.35 per cent, or 13.5 per thousand. A comparison of the figures for 1876 and 1900 shows that the disease has increased materially among the Hawaiians in the twenty-four years intervening.

This fact must be kept in mind when examining the chart showing the number of lepers segregated each year and the number of

^a In 1900 the foreign-born population was 116,366, with 63 known lepers. This shows 0.054 per cent, or 0.54 lepers per 1,000.

cases in each five-year period. An examination of the accompanying chart (Pl. I) shows that there has been a gradual decrease in the number of known cases of leprosy in the Territory during the last ten years. This is best shown in the curve representing the cases by five-year periods. In spite of this apparent decrease in the disease, in the light of the figures given above, the disease is in reality on the increase among the Hawaiians, although this fact is masked in the tabulations, which only deal with total cases, by the great decrease in the number of the afflicted race.

The Territory of Hawaii is conveniently divided by islands as follows: Oahu, Hawaii, Maui and Lani, Kauai and Nihau, and Molokai. In a statistical study of this sort the island of Molokai can be disregarded, for, excluding the leper settlement, an insignificant number of cases arise on this island.

An analysis of the board of health records for the thirty-one years from 1875 to 1905 shows the following distribution of cases by islands:^a

Island.	Total cases.	Annual average.
Oahu.....	1,585	51
Hawaii.....	1,208	38
Maui and Lani.....	1,043	33
Kauai and Nihau.....	450	14

The yearly variation in the number of cases from each island corresponds with the variation in the total cases. The cause of this variation will be discussed later.

It will be observed that the largest number of cases come from the island of Oahu. In a general way this distribution of cases corresponds with the relative number of inhabitants of the respective islands. A closer analysis of the figures shows that Maui yields somewhat more cases in proportion to its population than do the other islands. When the number of cases coming from each island each year are compared it is found that in the last six years there has been a slight increase in the number of cases from the island of Oahu and a corresponding decrease in the number of cases from the other islands. It is possible that this change is due to a movement of the native population from the rural to the urban districts. Another explanation is that the increased number of leper apprehensions from the island of Oahu is due to greater vigilance in the enforcement of the laws of segregation.

As will be shown later in more detail, the statistics plainly indicate that the occurrence of leprosy in this Territory is associated with the centers of population and is not a disease of the remote districts.

^a The board of health records before 1875 do not show the island or origin of the case.

The board of health records since 1881 show the island district as well as the island from which the case originates. A tabulation of this data for the following twenty-five years is given below:

Island.	District.	Cases.	Island.	District.	Cases.
Oahu.....	Kona (Honolulu).....	1,007	Maui.....	Wailuku.....	363
Do.....	Ewa.....	61	do.....	Kahikini.....	63
Do.....	Wainae.....	33	do.....	Hana.....	144
Do.....	Waiolu.....	74	do.....	Hamakua.....	67
Do.....	Koolauloa.....	57	do.....	Makawao.....	42
Do.....	Koolaupoko.....	80	do.....	Koolau.....	26
Hawaii.....	Hilo.....	211	do.....	Lani.....	11
Do.....	Puna.....	50	Kauai.....	Kona.....	141
Do.....	Kau.....	93	do.....	Puna.....	94
Do.....	Kona.....	257	do.....	Koolau.....	11
Do.....	Kohala.....	228	do.....	Halelea.....	70
Do.....	Hamakua.....	116	do.....	Napali.....	31
Maui.....	Kona (Lahaina).....	131	do.....	Nihan.....	11

It is not possible to work out fully the ratio of cases of leprosy to the number of inhabitants of each island district, as the census districts do not always coincide with the old native districts which are used by the natives in telling where they live. In certain cases the census districts do coincide with the native districts, and in these cases it is evident that the incidence of leprosy in the Territory is in close relation with the number of inhabitants in the different districts. The most striking thing brought out in this part of the inquiry is that leprosy in Hawaii is most common in the largest center of population, namely, in the Kona district of Oahu, which includes the capital city of this Territory, Honolulu.

Examination of the chart (Pl. II) and island maps (Pls. III-VII) show clearly that in the last twenty-five years leprosy has been more prevalent in Honolulu than in any other part of the Territory. One explanation of this grouping of the cases in the urban districts is that it is due to the fact that natives who become suspected of having leprosy in the rural districts come to Honolulu for treatment or better concealment. I think a more reasonable explanation is that the conditions of life in the native quarters of Honolulu furnish better opportunities for transmission of the disease.

Whatever the explanation may be the fact remains that if we select a year which yields about the average number of cases of leprosy for the whole Territory, such as 1891, with 142 cases, the distribution by islands and districts is as follows:

Island.	District.	Cases.	Island.	District.	Cases.
Oahu.....	Kona (Honolulu).....	39	Hawaii.....	All districts.....	42
Do.....	Ewa.....	0	Maui.....	do.....	27
Do.....	Waianae.....	2	Kauai.....	do.....	12
Do.....	Waiolu.....	4	Molokai.....	do.....	11
Do.....	Koolauloa.....	0			
Do.....	Koolaupoko.....	4	Total.....		142
Do.....	Unknown.....	1			

In short, over 35 per cent of the cases that year came from Oahu and over 27 per cent of all the cases came from Honolulu. The year 1891 was not an exceptional one, for as many as 155 cases of leprosy have been apprehended in Honolulu in a single year (1888).

AGE.

The board of health records for the period 1901–1905 have been tabulated with regard to the age of the patient when apprehended, and an analysis of this data shows that leprosy in Hawaii is principally a disease of children and young adults.

The 460 cases in this period when arranged in age periods of ten years show the following distribution. (See also Pl. viii.)

Age.	Cases.	Age.	Cases.
1 to 10 years.....	32	51 to 60 years.....	32
11 to 20 years.....	160	61 to 70 years.....	18
21 to 30 years.....	108	71 to 80 years.....	3
31 to 40 years.....	67		
41 to 50 years.....	40	Total	460

The youngest case was 5 years and the oldest 75 years of age. The average age at apprehension was 29.6 years.

SEX.

There were 301 males (65.5 per cent) and 159 females (34.5 per cent) among the 460 cases segregated during the period 1901–1905.

The disease in other countries shows a similar sex distribution, and, as in other infectious diseases, the explanation of the slight preponderance of males is probably to be sought in their mode of life and work yielding greater opportunities for infection.

The sex distribution does not show enough difference to suggest a hyper-susceptibility among males.

NATIONALITY.

During the five-year period 1901–1905 the nationality of the lepers segregated was as follows:

Race.	Cases.	Per cent.
Hawaiian and part Hawaiian.....	384	83.5
Chinese	31	6.8
Japanese	10	2.2
Portuguese	15	3.2
All others	20	4.3
Total.....	460	

These figures can be compared with those of the five-year period 1881-1885, in which time 778 cases were segregated, the nationalities being as follows:

Race.	Cases.	Per cent.
Hawaiian and part Hawaiian	757	97.30
Chinese	11	1.80
Japanese	0	.00
Portuguese	2	.26
All other	5	.64

A comparison of these figures show that leprosy is becoming more and more a disease of all inhabitants and is no longer almost entirely confined to the native race. This statement does not conflict with that previously made with regard to the occurrence and geographical distribution of the disease; for leprosy, although appearing among other than Hawaiians, even now hardly figures as a disease yielding statistical data worthy of minute analysis.

CIVIL STATE.

Among the 460 cases of leprosy segregated from 1901 to 1905, inclusive, 139 were married, 184 were over 14 years of age and single, 91 were under 15 years and single, 30 were widows or widowers, and 16 gave no information as to their civil state.

Civil state.	Number.	Per cent.
Married or widowed	169	36.7
Single	275	59.8
Not known	16	3.5
Total	460	100

DURATION OF THE DISEASE BEFORE APPREHENSION.

The record of the cases of leprosy segregated after 1900 frequently gave the date at which the patient first noticed symptoms of the disease. In 298 cases such information was given. The average time that elapsed between the appearance of the first symptoms noticed by the patient and the official examination was a little less than four years.

If these statistics can be relied on, it is a matter of prime importance in the question of the control of leprosy by segregation. It is obvious that segregation is effective only in so far as it removes from contact with the healthy members of the community those who are capable of transmitting leprosy. In the present state of our knowledge we must assume that leprosy is infectious during the whole of its course. This being the case, it is of the utmost importance that the cases be put

in isolation as early in the disease as possible. If lepers are to spend on an average four years free in the community before they are segregated, there seems little hope of an early disappearance of the disease as a result of segregation. The data on which this conclusion rests might be criticised, as they are based on the unsupported statements of the patients. This objection can be met by the argument that in all probability the number of cases who would try to minimize the importance of their symptoms by stating that they had had it for years would be offset by those who would attempt to influence the examining physician by saying that the symptoms inquired about were of recent origin. Aside from these considerations an inspection of a group of suspects during the official examination would convince anyone that the disease in the majority of instances was not of very recent origin.

FAMILY HISTORY.

Eighty-four cases out of 460 gave some family history of the disease. I am not inclined to lay much stress upon the data so gathered, for it is exceedingly improbable that the patients, whatever their suspicious might be, would reveal the source of their infection. This reticence is only broken through when a member or members of the family are already subjects of segregation. One cause for this secretiveness is the widespread belief among the Hawaiians that leprosy is a disease transmitted by sexual intercourse.

Relationship to known lepers.

	Cases.
Father or mother	36
Brother or sister	24
Cousin, uncle, aunt, etc.	18
Father and mother	6
Husband or wife	5
Son or daughter	2
Friend	3

ATTITUDE TOWARD SEGREGATION.

The attitude of the Hawaiians toward segregation is well shown in the way in which cases of leprosy are hidden for long periods of time. Such occurrences are common, not alone in the remote country districts, but in Honolulu itself. A cursory inspection of the cases that are brought to the receiving station in Honolulu shows at a glance that many cases must have been unmistakably lepers for years. The natives have a very clear idea of what a leper looks like and would be more apt to err in suspecting nonlepers than in mistaking a fully developed case of tubercular leprosy with a leonine countenance for a healthy person. It is evident that many of the cases examined must have been known as lepers to many persons for

a considerable time before they are presented for examination. Such hiding of cases could not go on without the connivance of many persons. It seems certain that there is passive resistance to the law although at present resistance by force is unknown.

The board of health has been unceasing in its efforts to improve the conditions of life at the leper settlement, and it is becoming generally known that the leper settlement is as comfortable a place to live as there is on the islands. Of course such knowledge becomes disseminated slowly through the native population and in time will help the enforcement of the leper laws.

THE MECHANISM OF CONTROL OF LEPROSY.

The delicate matter of collecting cases suspected of leprosy has been managed in various ways in this Territory and with varying results. It is the legal duty of all officers of the law and others to report to the board of health all cases suspected of being lepers.

At the present time there are no officials definitely charged with the sole task of seeking out lepers, with the exception of a police officer attached to the board of health office in Honolulu, whose time is occupied in the main in escorting suspects to and from the interisland steamers.

I am informed that in the last four years almost all the cases examined appeared voluntarily. It may be significant, in view of this, that the number of lepers segregated is falling off. This state of affairs may also have to do with the advanced stage of the disease shown by many of those who appear for examination. It is obvious that if segregation is practically voluntary, so far as appearing for examination is concerned, cases will not be delivered up to the authorities until concealment is no longer possible.

At present if a leper suspect is reported to the board of health in Honolulu the leper officer is sent to bring the case in for examination.

In case the suspect is on one of the other islands or is in a remote part of the island of Oahu a letter is sent to the government physician in the district and a letter is also sent to the suspect requesting him to appear for examination. The board of health furnishes transportation to Honolulu, and in case the suspect is declared a nonleper he is returned to his home free of expense. A surprising number of cases obey this summons.

When the case arrives in Honolulu it is either sent to the Kalihi receiving station or is allowed to stay with friends or relatives in Honolulu. As soon as practicable a bacteriological examination is made by the territorial bacteriologist. As soon as a convenient number of cases have accumulated an official examination is held at the receiving station, and those cases declared lepers are shipped to the Molokai settlement as soon as possible.

The present law requires that the examination of leper suspects be conducted by two licensed physicians, one of whom is to be selected by the board of health and one by the patient. If the two physicians do not agree on the diagnosis of the case they select a third physician and a second examination is held.

At the second examination, if two of the physicians agree on the diagnosis it is final. The law reads that the person must be suffering from leprosy and be capable of spreading the disease.

The facilities for the care of lepers and leper suspects deserve favorable mention. The Territory has established and maintains a receiving station at Kalihi, a suburb of Honolulu, for the care of suspects, and a settlement at Kalaupapa, on the island of Molokai, for the permanent segregation of those declared lepers.

The Kalihi receiving station consists of a group of frame buildings, surrounded by a high double fence, situated in a remote part of a suburb of Honolulu, near the seashore. The station furnishes shelter and subsistence for as many as thirty cases. The station is in charge of a native keeper and his wife, supplemented by a matron, who has particular charge of the children and young girls. Leper suspects are detained at this hospital pending examination, and after certification the declared lepers are kept there until a sufficient number are accumulated to warrant a special trip of the interisland steamer direct to the leper settlement on Molokai. In former times this station at Kalihi has been used as an experiment station and treatment has been given. At present no treatment is given there.

An addition to the Kalihi station is planned, and an appropriation is available for its erection. This addition will furnish facilities for laboratory work and for the housing and hospital treatment of twelve additional cases.

The bulk of the known lepers in the Territory are concentrated at the leper settlement at Kalaupapa, on the island of Molokai.

In recent years, largely owing to the efforts of Mr. L. E. Pinkham, president of the territorial board of health, the settlement on Molokai has been converted into a comfortable native village which compares favorably, as a place of residence for the natives, with any of the villages on these islands. A pamphlet describing the leper settlement at Molokai has just been issued by the board of health of the Territory of Hawaii and it seems unnecessary to repeat here the information there given.^a

At the leper settlement are homes for boys, for women and girls, and for the helpless of both sexes. The religious needs of the inmates are ministered to by Catholic, Protestant, and Mormon clergy. A general hospital is in process of construction, which will be equipped with a good operating room.

^a The Molokai settlement, Territory of Hawaii, village of Kalaupapa and Kalakao. Publications board of health of the Territory of Hawaii, 1907.

In former times various attempts have been made to conduct systematic studies of leprosy in this Territory, but all efforts to this end have been more or less abortive, partly on account of the unfortunate political and social elements which complicated the problem here and partly on account of an absence of tact on the part of the investigator or the authorities.

At the present time the Territory, under American rule, has encouraged research on the part of the physicians in charge of the health of the leper settlement, and is constantly increasing their facilities for such work. I can not speak too highly of the work of Doctors Goodhue and Hollman at the leper settlement, who are doing work which reflects great credit upon their persistence and ingenuity in accomplishing things against material difficulties of the most harassing sort.

It is to be hoped that a new era in the study of leprosy in Hawaii will be inaugurated with the opening of the Molokai leprosy investigation station, under the Public Health and Marine-Hospital Service. Congress has appropriated money to build and equip a 40-bed hospital station with an up-to-date laboratory and has made provision for the maintenance of the institution. This station is intended primarily for the study of the disease, 40 patients being taken from the settlement for treatment and study. With the continuity of policy made possible by this provision and with sufficient means to employ a trained staff of investigators it seems reasonable to expect of such an investigation station advance in our knowledge of leprosy that will help in solving this most difficult of public health problems both here and elsewhere.

SUMMARY.

Leprosy has been a public health problem for forty years in the Territory of Hawaii. During that time an attempt has been made to control the disease by segregation. In spite of the more or less vigorous enforcement of segregation, leprosy has increased among the Hawaiians and is becoming more and more a disease of the inhabitants of the Territory of other races. The fact that there are more known lepers per capita among the Hawaiians now than formerly might be due to more strict segregation, but I am not inclined to believe this to be the real explanation. The increasing numbers of non-Hawaiian lepers, shown among the Portuguese and Japanese particularly, is probably due to importation as much as to infection acquired in this Territory. Both the races named must be classed as people among whom leprosy is common at home. The important conclusion to be drawn from this fact is that leprosy in Hawaii will not continue to be a problem related to the native race alone, but will persist and always be a menace unless some effective means be devised to check its spread.

The geographical distribution of the disease in the Territory shows that the disease is most common in the larger centers of population, particularly Honolulu.

Many difficult problems will have to be met and solved if leprosy is to be gotten under control in this Territory.

From a public-health standpoint the most urgent problem is how to get lepers segregated early in the course of the disease. Two general lines of policy may be pursued to this end: First, to improve the conditions of care for lepers so as to increase the number who will surrender voluntarily; and, second, to use every means possible to collect cases of the disease.

CONCLUSIONS.

First. The leprosy problem in Hawaii calls for more thorough enforcement of the laws of segregation.

Second. The field for the study of leprosy furnished by the Territory of Hawaii is unsurpassed and merits the most painstaking efforts to utilize it to the utmost.

LEPROSY IN HAWAII.

CASES SEGREGATED BY YEARS, 1866-1905.

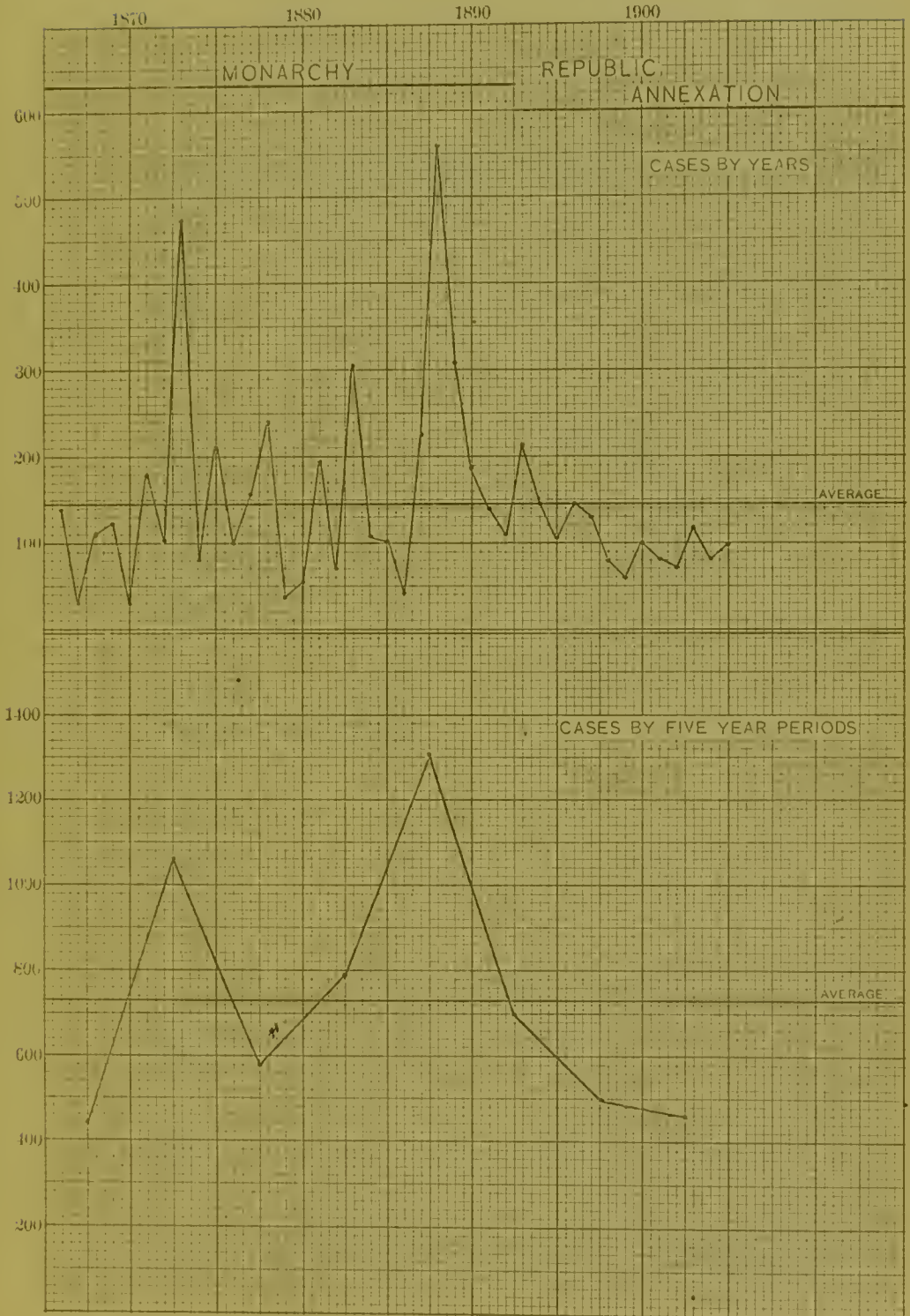
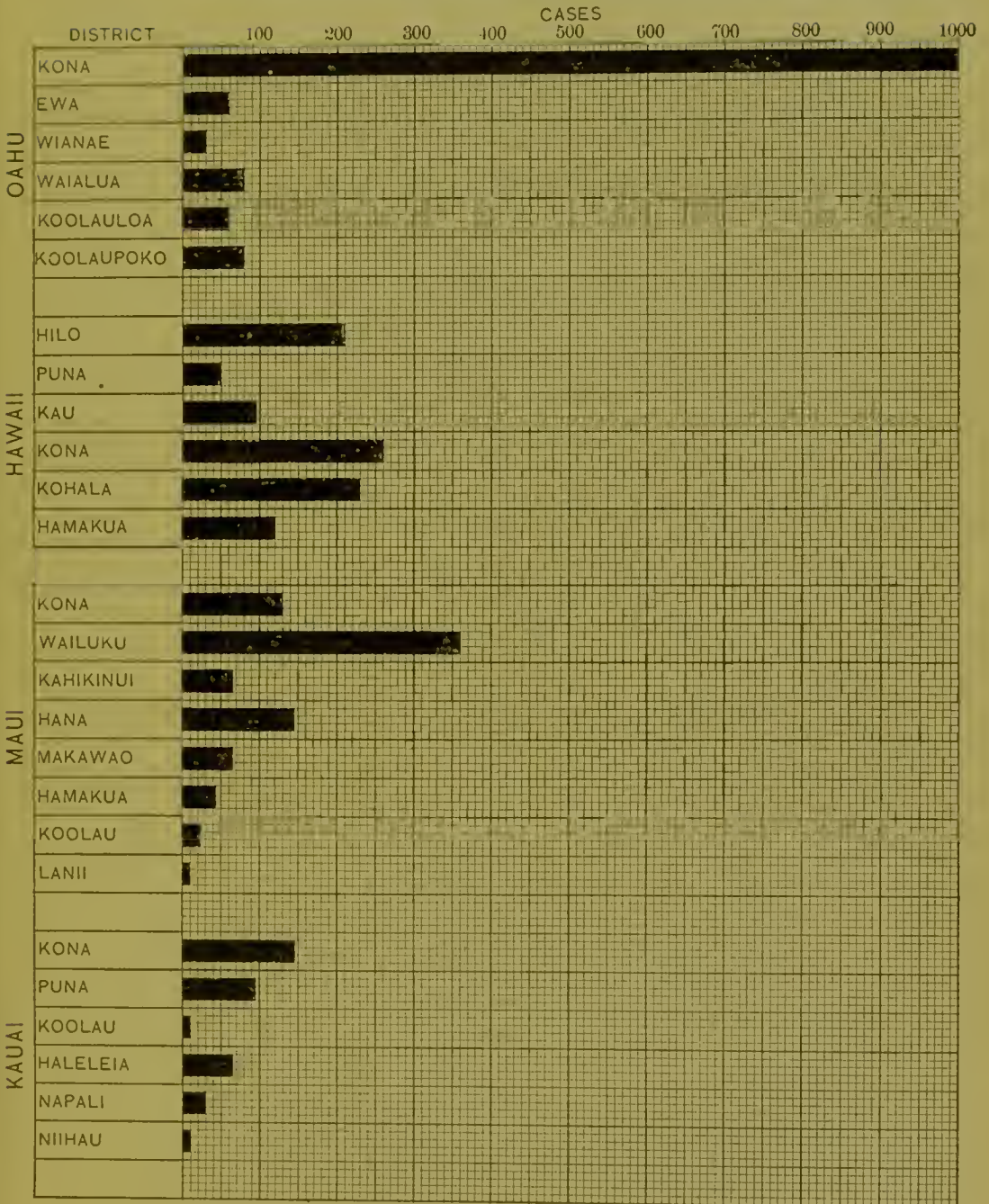


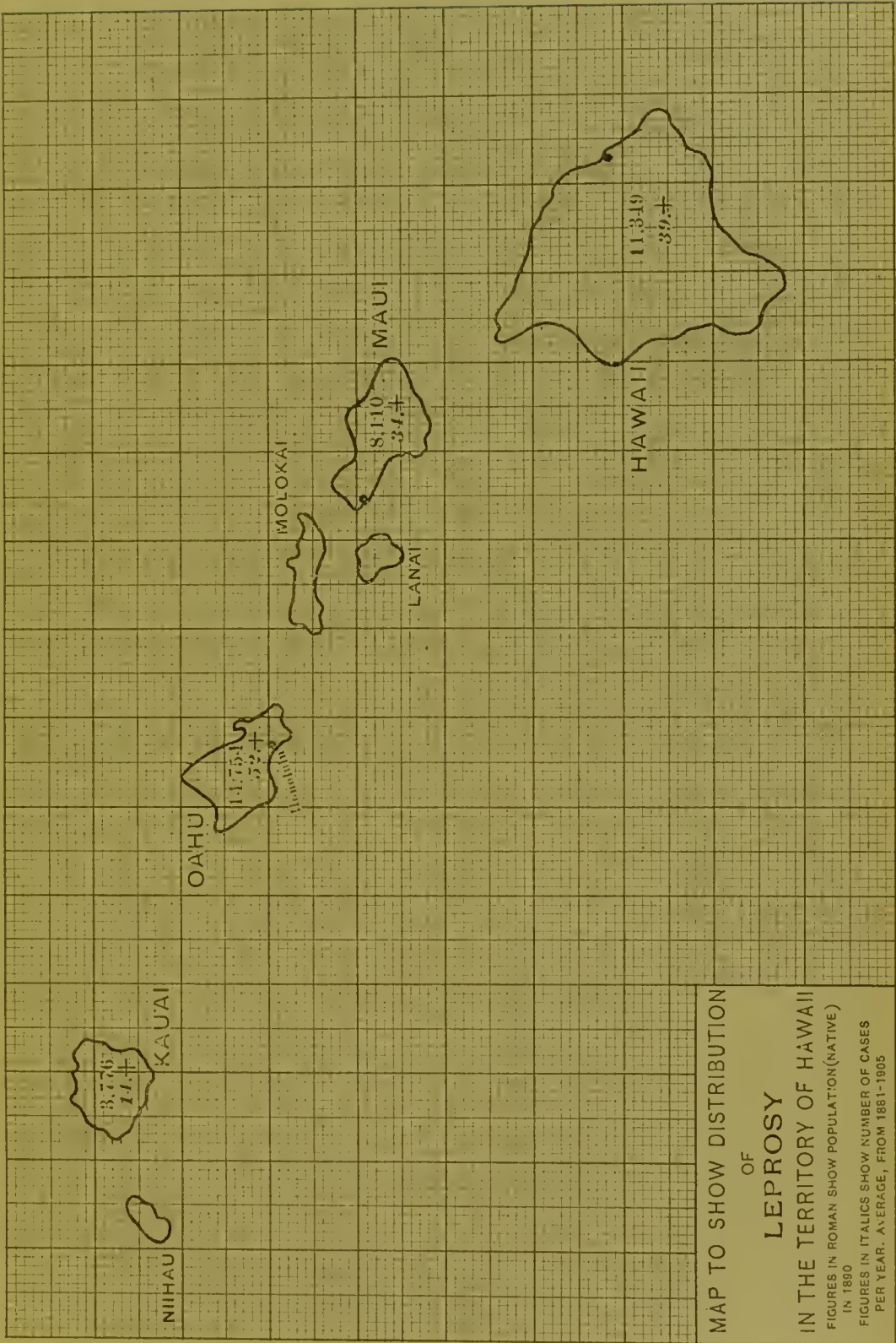


PLATE II.

LEPROSY IN HAWAII.

OCCURRENCE OF CASES BY DISTRICTS.
TOTAL CASES IN TWENTY-FIVE YEARS.





MAP TO SHOW DISTRIBUTION
OF
LEPROSY
IN THE TERRITORY OF HAWAII
FIGURES IN ROMAN SHOW POPULATION (NATIVE)
IN 1890
FIGURES IN ITALICS SHOW NUMBER OF CASES
PER YEAR. AVERAGE, FROM 1881-1905



PLATE IV.

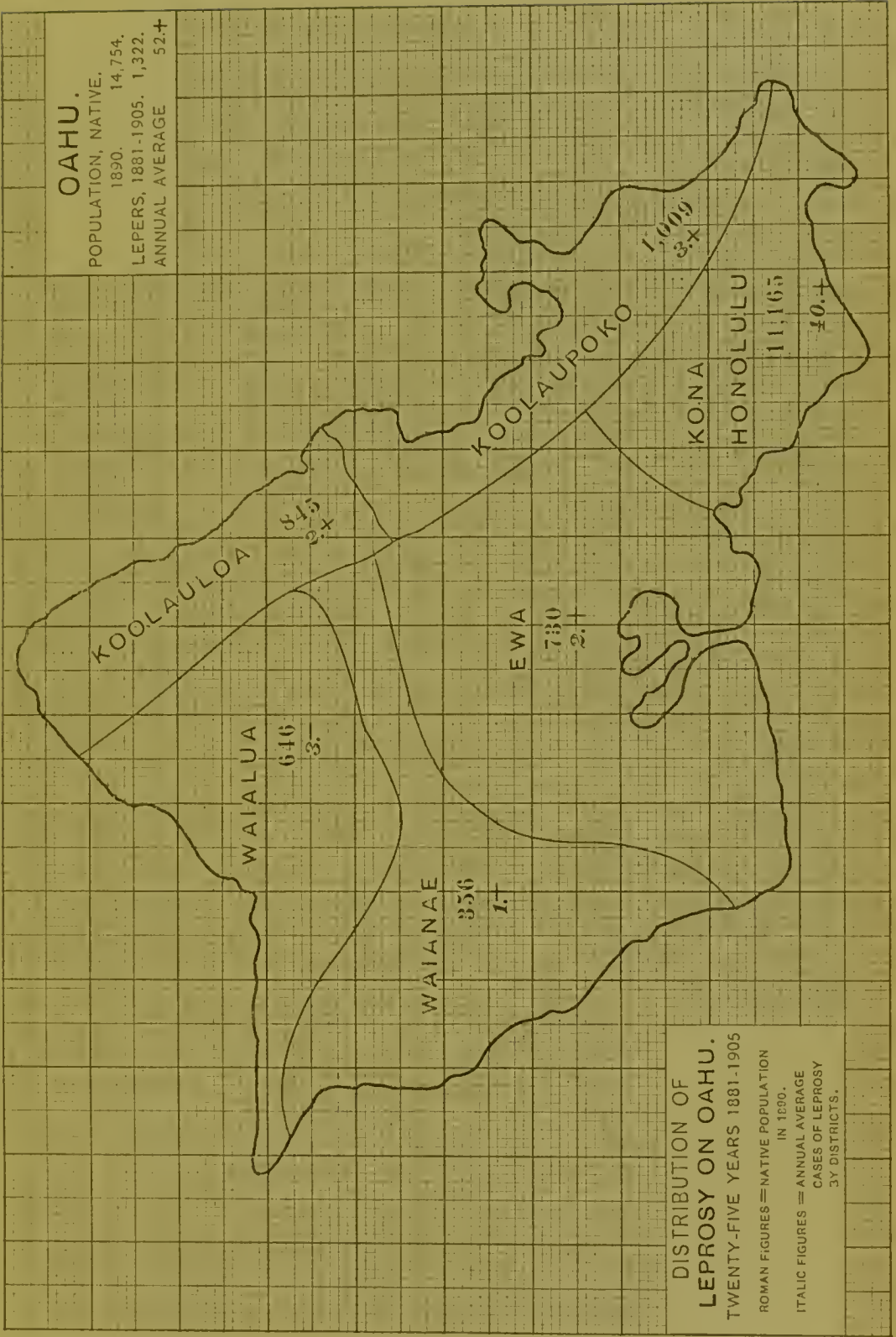


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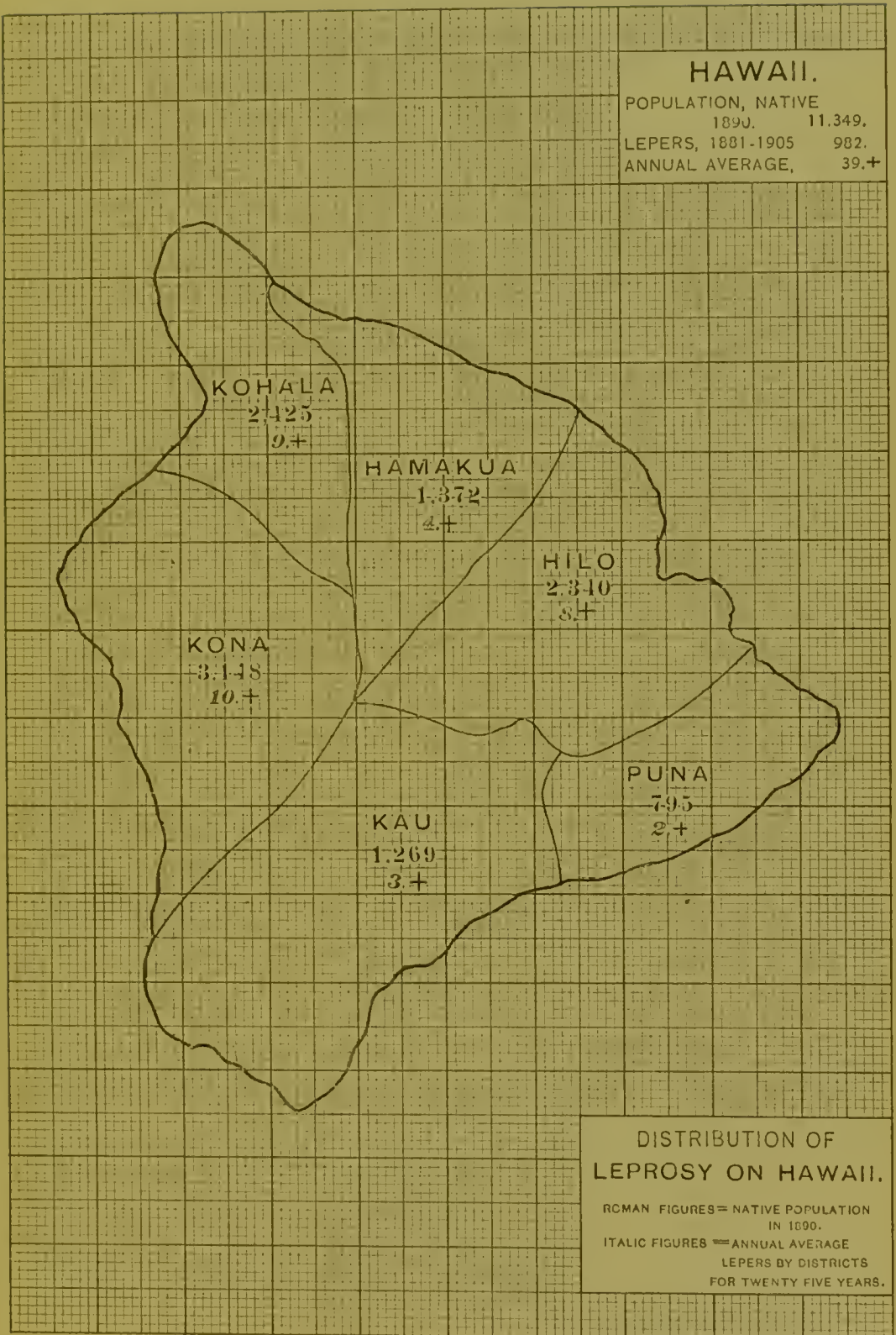
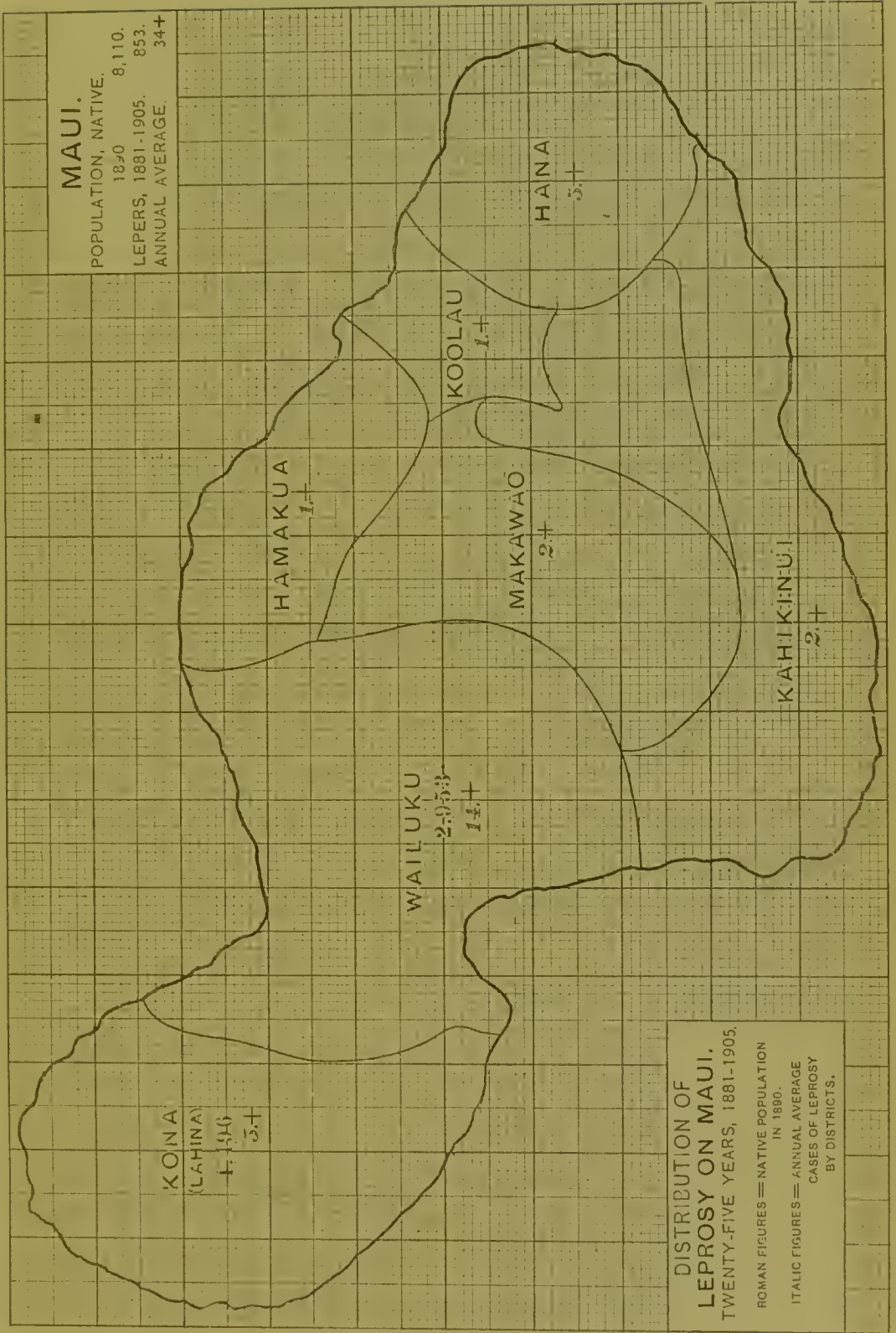
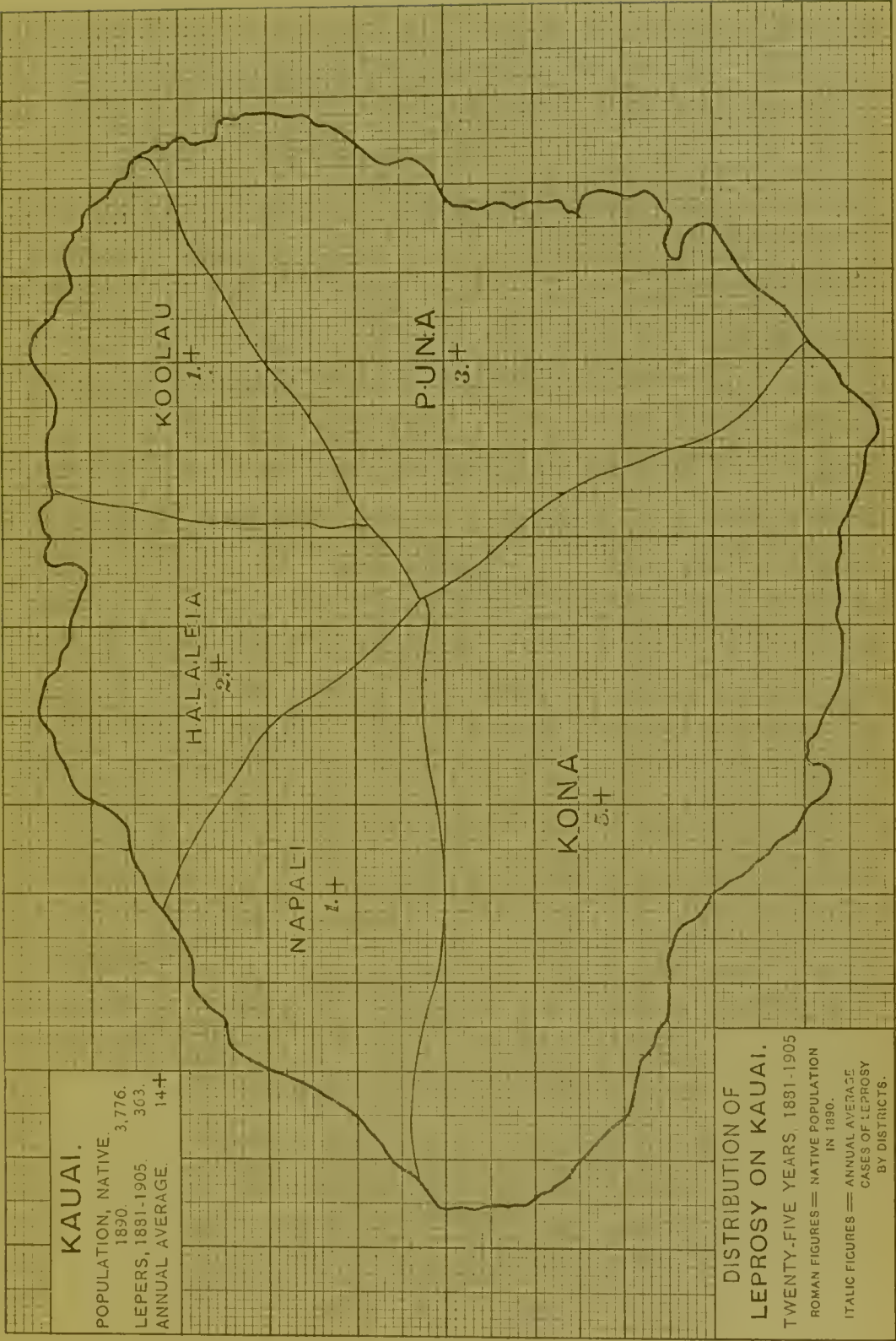




PLATE VI.



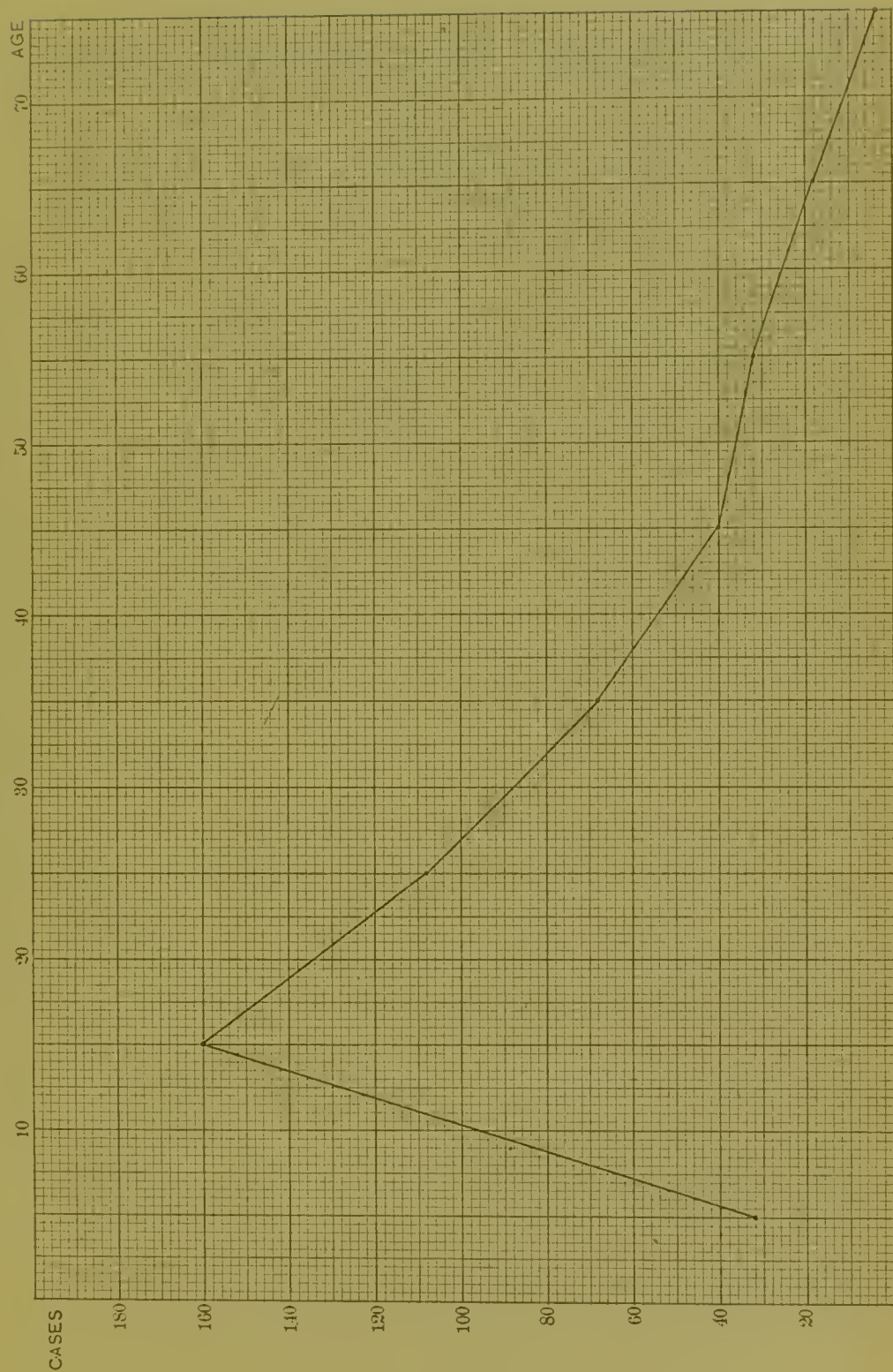






LEPROSY IN HAWAII.

DISTRIBUTION OF CASES IN AGE PERIODS OF TEN YEARS, 1901-1905.





THE REACTION OF LEPERS TO MORO'S "PERCUTANEOUS" TEST.

By WALTER R. BRINCKERHOFF, S. B., M. D.,

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The investigation detailed below was undertaken primarily to determine if Moro's "percutaneous" tuberculin test would prove of value in the differential diagnosis of lepra. As a by-product of research it was hoped that some light would be thrown on the biochemical relationship of the tubercle bacillus and the lepra bacillus.

Review of literature.—Moro (1) has found that cases of scrofula in children react characteristically to the inunction of a salve composed of Koch's old tuberculin and lanolin. The salve is rubbed on the skin of the abdomen just below the manubrium. A positive reaction is shown by the appearance of a "knötchenförmigen papulösen Effloreszenzen" at the site of the inunction. It has long been known that lepers react, both locally and constitutionally, to subcutaneous injections of tuberculin. (Babes and Kalindero, 1891 (2), and others.)

Technique.—A salve was made by rubbing together equal volumes of Koch's old tuberculin (Mulford & Co.) and sterile lanolin.

A small amount of this salve was rubbed on the skin of the abdomen of each patient over an area of about 2 cm. square for a half to one minute. The cases were seen after four hours, twenty-four hours, two days, and three days. The cases selected for the test may be arranged in three series, as follows:

Series 1. Five cases of leprosy under treatment with Nastin. Three of these were mixed cases and two were of the tubercular type.

Series 2. Eight cases of leprosy which had received no specific treatment. Of these two showed only a macular area on the cheek, three were tubercular cases, one was mixed, and one was of the nerve type.

Series 3. Nine cases in which no suspicion of leprosy was entertained. Of these five were cases of pulmonary tuberculosis, in which the bacilli had been demonstrated in the sputum. Four cases were considered nontubercular and were in the hospital under the following diagnosis: Mitral regurgitation, chronic ulcer of the leg, sarcoma of the ear, and hemiplegia.

CLINICAL OBSERVATIONS.

SERIES I. *Lepers under Nastin treatment*

No. 724. Type of disease, tubercular; age, 10 years; sex, male; duration of disease unknown; family history, negative; nationality, part Hawaiian. Physical examination: Areas of infiltration on both cheeks and forehead; many nodules on both ears. Under treatment with Nastin for five months and three weeks.

Tuberculin salve rubbed on skin of abdomen 11 a. m. May 8, 1908. No reaction observed till the morning of May 11. Seen at 3 p. m. the same day. The area rubbed with the salve presented three papular elevations 1.5 mm. in extent. The adjacent skin was not reddened. The reaction was still visible on the next day and then rapidly faded. No subjective symptoms.

No. 736. Type of disease, mixed; age, 16 years; duration of disease, at least two years; family history, negative; nationality, American. Physical examination: Linear scar on rim of left ear where tubercle had been excised. Second toe on right foot amputated. Operation wound healed. Great toe on same foot shows absence of terminal joint and recent cicatrix of operation for excision and curetment of planter pedio ulcer. Under treatment with Nastin for five months and three weeks.

Tuberculin salve rubbed on the skin of abdomen at same time and in same manner as No. 742. No reaction observed at any time.

No. 744. Type of disease, tubercular; age, 40 years; sex, male; duration of disease, two years; family history, negative; nationality, part Hawaiian. Physical examination: Cheeks and forehead show large areas of infiltration; ears enlarged and nodular. Fingers enlarged and tapering. Under treatment with Nastin for five months.

Tuberculin salve rubbed on skin of abdomen at same time and in same manner as previous case. After four hours the area rubbed with the tuberculin salve showed numerous shotty papular elevations 1 to 2 mm. in extent. The papules were bright red, but there was no flushing of the adjacent skin. The patient gave a history of "asthma," and raised a small amount of tenacious sputum by coughing in the morning. Bacteriological examination of the sputum showed occasional groups of acid fast bacilli having the morphology, staining reaction, and grouping characteristic of bacillus lepræ. No single acid fast bacilli were found. There was no clinical evidence of tuberculosis. The cutaneous reaction was still visible after three days and then faded.

No. 742. Type of disease, mixed; age, 30 years; sex, male; duration of disease, over two years; family history, negative; nationality, Portuguese. Physical examination: Nodules on left ear; some thickening of skin of forehead; eyebrows thin; hands swollen and dorsum

dusky red; fingers swollen and tapered. Complains of numbness of forearm and hand in distribution of ulna nerve. Some thickening of nerve at elbow. Patient has been in Japan for hot bath treatment. Under treatment with Nastin for four months and two weeks.

Tuberculin salve rubbed on skin of abdomen at same time and in same manner as previous cases. No reaction observed till morning of May 11. Inspected at 3 p. m. same day, two days and four hours after the tuberculin salve had been applied. Area of inunction presents four papules similar to those described above. Reaction persisted for two days and then rapidly faded.

No. 762. Type of disease, mixed; age, 19 years; sex, male; duration of disease, four years; family history, a cousin declared a leper and segregated four years ago. Nationality, part Hawaiian. Physical examination: Large area of induration on left cheek and forehead, eyebrows almost completely gone, small nodule in lobe of left ear, leucodermic areas on trunk and limbs. Complains of numbness of outer aspect of right forearm. Under Nastin treatment two weeks.

Tuberculin salve rubbed on skin of abdomen at the same time and in the same manner as in previous cases. No reaction observed till the morning of May 11. When seen at 3 p. m. the same day, two days and four hours after the tuberculin salve had been applied, the area of inunction presented six red papules such as described above. The reaction persisted for a few days and then faded.

SERIES 2.—*Lepers who had received no specific treatment.*

No. 725.^a Type of disease, macular; age, 3 years; sex, female; duration, one year; family history, born in the leper settlement of leper parents. Nationality, Hawaiian. Physical examination: Thickening, with slight elevation of skin on right cheek over an area 3 by 8 cm. in extent. Macular area a dusky red color. Similar macules on both thighs and on left knee.

Tuberculin salve rubbed on skin of abdomen in the same manner as in series 1, May 26, 1908, at 11 a. m. Inspected at 3 p. m. the same day and daily for the three days succeeding. No reaction observed at any time.

No. 726.^a Type of disease, macular; age, 4 years; sex, female; duration of disease, one year. Family history: Born in the leper settlement. The records do not show the parentage. Nationality, Hawaiian. Physical examination: Elevated, dusky red macular area 2 cm. in extent on right cheek. Scattered leucodermic areas with same distribution.

^a These cases were not sufficiently advanced to classify them as tubercular, nerve, or mixed type.

Tuberculin salve rubbed on skin of abdomen at same time and in same manner as previous case. Inspected at same times as previous case. No reaction observed at any time.

No. 764. Type of disease, tubercular; age, 9 years; sex, male; duration, unknown, but from appearances of patient probably several years. Mother a leper now at the leper settlement. Nationality, Hawaiian. Physical examination: Numerous tubercles on face and ears. Macules on trunk and extremities. Nasal obstruction with snuffles. Fingers enlarged and tapered.

Tuberculin salve rubbed on skin of abdomen in same manner and at same time as previous case. No reaction at any time.

No. 688. Type of disease, tubercular; age, 10 years; sex, female; duration, over two years; family history, negative; nationality, part Hawaiian. Physical examination: Large areas of infiltration on both cheeks and forehead. Ears enlarged and beset with tubercles. Both hands swollen; fingers enlarged and tapered.

Tuberculin salve rubbed on skin of abdomen in same manner and at same time as previous case. No reaction observed at any time.

No. 766. Type of disease, mixed; age, 24 years; sex, female; duration of disease unknown, but probably several years; family history, negative; nationality, Portuguese. Physical examination: Thickened, indurated, dusky red area over right malar eminence. Small tubercles on forearms, wrists, knees, and legs. Two fingers of right hand enlarged and tapered. All fingers of left hand shortened and atrophied.

Tuberculin salve rubbed on skin of abdomen in same manner and at same time as previous case. Case seen after four hours and each day thereafter for three days. Three red papules seen on the area where salve was rubbed forty-eight hours after inunction. The papules were similar to those observed in the positive reaction of the previous series. The papules were visible for a few days and then disappeared.

No. 763. Type of disease, nerve; age, 20 years; sex, female; duration, one year; family history, negative; nationality, Hawaiian. Physical examination: Macules on trunk. Right hand typical main en griffe.

Tuberculin salve rubbed on skin of abdomen in same manner and at same time as previous case. Two red papules, similar to those observed before, appeared after forty-eight hours.

No. 602. Type of disease, tubercular; age, 22 years; sex, male; duration, three years. Family history: Sister is a leper now at the leper settlement. Nationality, part Hawaiian. Physical examination: Left arm amputated at junction of middle and upper thirds of forearm. Right ear shows linear scar where tubercle had been excised.

Ears slightly enlarged and presents numerous small nodules. Eyebrows thin and patchy.

Tuberculin salve rubbed on skin of abdomen in same manner and at the same time as the previous case. No reaction was observed at any time.

No. 749. Type of disease, tubercular; age, 46 years; sex, female; duration of disease, over one year; family history negative; nationality, part Hawaiian. Physical examination. Typical leonine facies. Macules on trunk and extremities.

Tuberculin salve rubbed on skin of abdomen at same time and in same manner as previous case. No reaction was observed at any time.

All of the cases in these two series had been examined by the territorial bacteriologist and the bacillus lepræ had been found.

SERIES 3.

These cases were under treatment in the Leiahi home in Honolulu. No suspicion of leprosy was entertained in any case.

As stated above, the cases were pulmonary tuberculosis and cases in which there was no clinical evidence of tuberculosis. It seems needless to detail the clinical histories of these cases further than to say that the cases of phthisis were all reacting to fresh air and diatetic treatment, and that the diagnosis of phthisis had been confirmed by microscopic examination of the sputum.

SUMMARY.

The reaction of the cases to the innunction of the tuberculin salve can be conveniently summarized by the following tabulation:

TABLE.

SERIES 1.—*Lepers, Nastin treatment.*

No.	Type.	Reaction.
724	Tubercular	Delayed, slight.
735	Mixed	None.
741	Tubercular	Prompt, marked.
742	Mixed	Delayed, slight.

SERIES 2.—*Lepers untreated.*

725	Macular	None.
726	do	Do.
764	Tubercular	Do.
688	do	Do.
766	Mixed	Delayed, slight.
763	Nerve	Do.
602	Tubercular	None.
749	do	Do.

SERIES 3.—*Nonlepers.*

No.	Type.	Reaction.
316	Phthisis.....	None.
354do.....	Do.
322do.....	Do.
293do.....	Do.
349do.....	Do.
325	Cardiac.....	Do.
154	Ulcer.....	Do.
332	Sarcous.....	Do.
63	Cerebral.....	Do.

DISCUSSION.

An examination of the above table would seem to dispose at once of the idea that the application of a tuberculin salve to the skin might be of assistance in the differential diagnosis of lepra and tuberculosis. The only deduction to be made is that a slight and delayed reaction would be in favor of lepra, though the number of cases on which this generalization is based is obviously inadequate and the selection of the nonleper patients not diversified enough to yield it proper support.

The most interesting thing shown by the reactions is that we seem to be dealing here with one of the "group reactions." With the exception of case No. 744, series 1, the cases which gave a reaction showed no clinical evidence of tuberculous disease, while they were undoubted lepers. Excluding the doubtful case (744), we find that the slight and delayed reactions occurred in three cases of mixed leprosy, one case of tubercular leprosy, and one case of nerve leprosy. On the other hand, one case of mixed leprosy, four cases of tubercular leprosy, and two unclassified cases gave no reaction. This being the case, if a positive reaction indicates the presence of tuberculosis and not leprosy, we have almost half of our cases of leprosy infected with tuberculosis without clinical evidence. As this seems hardly possible, the presumption would then be that the development of a reaction might be due to the leprous infection alone. This view is borne out by the fact that lepers react both locally and constitutionally to injection with tuberculin. I am therefore inclined to regard the positive reactions to the leprous infection and to explain the absence of reaction in many of the cases to the method of applying the agent.

In the above discussion we have disregarded the fact that the cases treated with nastin all reacted, with one exception, to the inunction of the salve. It is possible that if nastin has a specific action in tuberculosis, as stated by Deycke (3), it might serve to sensitize these lepers so that they would react to the tuberculin salve.

It seems probable that we are dealing with a group reaction in which we have interrelationship between the product of the lepra bacillus, tuberculin, nastin, or products of the lepra bacilli set free by the action of the nastin. In any case it serves to emphasize the close relation which exists between the chemical products of the lepra and tubercle bacilli. This would support the recommendation of Lie (4) that tuberculin be given a retrial in the treatment of leprosy.

CONCLUSION.

1. The "percutaneous" tuberculin test of Moro is of no value in the differential diagnosis of leprosy and tuberculosis.

2. A certain number of cases of leprosy, in which there is no clinical evidence of tuberculous infection, give a reaction to Moro's test.

3. The fact that lepers react to cutaneous inunction of a tuberculin salve may be taken as additional evidence of the chemical nearness of the product of the lepra and tubercle bacilli, and support the suggestion already made that tuberculin be given another trial in the therapeutics of leprosy.

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I take this opportunity to express my thanks to Dr. J. T. McDonald, territorial bacteriologist, for clinical data about certain of the cases employed in the above tests and Dr. A. N. Sinclair for permission to make use of clinical material under his charge.

A NOTE UPON THE POSSIBILITY OF THE MOSQUITO ACTING IN THE TRANSMISSION OF LEPROSY.

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The brilliant results which have followed the investigation of the rôle of biting insects in the transmission of certain infectious diseases has led to speculations and some investigations upon the possible intermediation of the mosquito in the transmission of leprosy. This paper is intended as a contribution to this problem, but can only lay claim to being of suggestive value.

The only discussions of the relation of the mosquito to the transmission of leprosy that I can find by a search of the literature accessible to me are those of Hutchinson (1) and Goodhue (2). The former advances six reasons why the mosquito theory of the transmission of leprosy is not tenable. An analysis of these reasons shows that although, if they were all unassailable, the mosquito might not be regarded as the sole means of transmission, yet with the data now at hand it is not possible to affirm that the insect can never so act. It is the purpose of this note to call attention to certain facts which indicate that it is mechanically possible for the mosquito to carry the lepra bacilli from one person to another and make it highly probable that if they be so carried they will be rubbed into the skin of the person bitten.

Goodhue, quoting observations of his brother, the resident physician of the territorial leper settlement at Molokai, Hawaii, states that he has found the lepra bacillus in the body of the female *Culex pipiens*. He did not find the bacilli in the salivary glands, though he seemed sanguine that he would do so later.

A number of years ago Mr. J. R. Taylor, laboratory assistant to Doctor Guiteras at Las Animas Hospital, Habana, Cuba, showed me a smear made from the stomach contents of a mosquito that had bitten a leper in which there was an acid-fast bacillus having the morphology of the lepra bacillus.

The two ways in which the mosquito might act as a transmitter of leprosy bacilli are comparable with the conditions which exist in the transmission of malaria by that insect and those which occur in the

transmission of plague by the flea. The first of these would require that the mosquito draw the bacilli into its stomach and that the bacilli then migrate through the stomach wall, pass to and penetrate the salivary gland. So far as I know there is no evidence that such migration of the bacilli takes place, and we would not expect it to occur in view of the absence of motility of the bacillus. Any comparison with the conditions in malaria are fallacious, as there we have to do with an animal parasite with a definite cycle of development which includes a motile migratory stage.

If we turn to the second possibility we have only to predicate that the mosquito permits the bacilli to pass through its intestinal tract without impairment of its virulence and deposits the bacilli at the time of a subsequent bite upon the skin of a healthy person. It is of this possibility that I wish to speak, for if this state of affairs exists an analogy can be established to the transmission of plague by the flea.

Banks (3), in studying malarial transmission by *Myzomyia ludlowii*, noted that when this mosquito bites for the first time it voids, from the anus, a small amount of serum-like fluid in a continuous stream of droplets.

At my request one of the patients at the Kalihi receiving station caught a mosquito, probably *Culex pipiens*, and watched it bite his arm. The coloration of the mosquito's abdomen by transmitted light indicated that it had fed on blood. The patient stated that he saw the mosquito defecate during the act of biting. This was confirmed by the nurse who watched the experiment. Unfortunately, I was not able to be present. A card was slipped under the glass which confined the mosquito, and on this was received the fecal matter. I made several smears from the small brown stain pointed out to me as the material deposited by the mosquito, but was unable to demonstrate any acid-fast bacilli. I have since had an opportunity to observe closely the common night mosquito of Hawaii in the act of biting. *Culex pipiens* was used. If the mosquito is allowed to light on the back of the hand or finger, after the proboscis is deeply inserted in the skin a bit of white paper can be held behind the insect without causing it to desist from the bite. This white background and a good light are necessary to see the details of the process. When the abdomen of the insect is partly filled with the blood the terminal segments of the abdomen of the insect are seen to writhe about with a corkscrew motion. The extreme end of the body suddenly elongates slightly, as though a short process were being extruded, and points upward and backward. At this moment, if a close watch be kept, a small amount of fecal matter will be seen to be projected violently upward and outward, falling on the skin at a distance of three or four millimeters from the posterior end of the

mosquito. The character of the material voided by the insect seems to depend upon whether it has previously digested a meal of blood. In such a case the material is in the form of minute formed masses of dark color. If the insect is drawing blood for the first time, the matter voided is colorless serum-like fluid, as described by Banks.

The mechanism for transference of leper bacilli by the mosquito from a leper to a healthy person's skin therefore exists, and, as the fecal material is deposited on the skin near a point of irritation, the person bitten may easily scratch the material into the skin, as is done in the transmission of plague. The only thing to prevent such a mode of transmission would be the possibility of the bacilli being rendered innocuous while in the mosquito's body or the powers of defense of the individual bitten successfully resisting invasion by the inoculated bacilli.

DISCUSSION.

Even if it be established that a mechanism exists whereby the mosquito can transmit lepra bacilli from a leper to a healthy person and deposit them on the skin in such a position that they will be mechanically inoculated into the person's tissues, it will still remain a question whether the insect plays a rôle in the actual dissemination of the disease. The evidence on the inoculability of leprosy through lesions of the skin is almost all on the negative side.

Data upon the geographical distribution of leprosy, with relation to the distribution of the mosquito, has not been compiled, so that such epidemiological argument can not now be applied to the discussion of the question.

CONCLUSION.

The fact that the female *Culex pipiens* defecates at the time of biting makes it possible that the insect may act as a carrier of leper bacilli from lepers to well persons.

The data now available does not permit of a positive statement that the mosquito functions in the transmission of leprosy, and the probabilities are against such a conclusion.

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